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Preemergent Herbicides for Preparing Ponderosa Pine Planting Sites in the Southwest

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On an area with dense perennial grass cover, atrazine at 10 pounds per acre resulted in heaviest grass kill (68 percent) and highest tree survival. Tree survival generally was poor, however, partly due to heavy grass competition because herbicides could not be applied early enough, and partly because of animals. Herbicides did not damage pine seedlings. (KEY WORDS: Herbicides, Pinus ponderosa, Festuca arizonica, Muhlenbergia montana, tree planting)

One of the problems in planting ponderosa pine (Pinus ponderosa Laws.) in the Southwest is competing vegetation, primarily perennial grasses. Grasses such as Arizona fescue (Festuca arizonica Vasey), which grow during the spring dry period in May and June, are capable of using most of the available soil moisture at the expense of newly planted pine seedlings. The cheapest and most effective method of eliminating grass is to kill it with herbicides.[2] In Arizona, we have found that soil moisture is significantly higher on plots with a dead grass mulch than on plots from which the grass has been entirely removed.[3] The differences are significant to a depth of 20 inches.

Several systemic herbicides have successfully killed perennial grasses in the Southwest. Dalapon, however, has proved to be the cheapest and most effective. A rate of 5 pounds (active ingredient) of the sodium salt of dalapon per acre usually results in a grass kill of 90 percent or more. Treated areas have remained relatively grass-free for 2 or 3 years.

A disadvantage of systemic herbicides is that they must be applied while the grass is actively growing. This means the herbicide must be applied the season before tree planting in a separate operation. The ideal situation would be to use an herbicide that could be applied at the same time the trees are planted. In Iowa, White[4] applied simazine to the soil from a sprayer mounted on a tree planter at the same time several species of conifers and hardwoods were planted. White did not mention unsprayed controls, but first-year survival on the sprayed areas was 89 percent compared to 60 to 75 percent for previous plantings. The herbicide was applied to ground that had already been prepared mechanically.

The Study

In 1965, a test of three preemergent herbicides was begun on two areas of the Fort Valley Experimental Forest near Flagstaff, Arizona. Area S-3, clearcut of sawtimber in 1963, had supported a mature stand of ponderosa pine that had averaged 11,000 board feet per acre. In 1965, there was

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[2] *Heidmann, L. J. Herbicides for preparing ponderosa pine planting sites in the Southwest. U. S. Forest Serv. Res. Note RM-83, 4 p., illus. 1967. (Rocky Mt. Forest and Range Exp. Sta., Fort Collins, Colo.)*

[3] *Heidmann, L. J. Use of herbicides for planting site preparations in the Southwest. J. Forest. 67: 506-509, illus. 1969.*

[4] *White, Gordon. Chemical weed control as a planting operation. J. Forest. 60: 256-257. 1962.*

almost no vegetation on the ground. The other area, Wing Mountain, supported a dense stand of perennial grasses, mainly Arizona fescue and mountain muhly (Muhlenbergia montana (Nutt.) Hitchc.) (fig. 1). Around the plots were scattered groups of saplings and small poles, with occasional sawtimber-size trees remaining from logging operations in the 1920's.

The study was a randomized block design with four replications. Each block consisted of two rows of five plots. In each plot five rows of five ponderosa pine seedlings were planted at a spacing of 3 by 3 feet. The trees were planted by hand, with the aid of planting bars. The 2-0 stock planted at S-3 was raised in the U.S. Forest Service Nursery at Placerville, California, from seed collected on the Kaibab National Forest near the Fort Valley Experimental Forest. At Wing Mountain, 3-0 stock raised in a small experimental nursery at Fort Valley was used. Tree planting was not completed until the end of May because of an exceptionally wet spring.

After planting, each of the 10 plots in a block was randomly assigned one of the treatments listed in tables 1 and 2.[5] Each herbicide was mixed with sufficient water plus a wetting agent[6] to obtain complete coverage of the vegetation, then applied with a 3-gallon, garden-type pressure sprayer. No effort was made to protect the trees from the spray solution.

Tree survival was checked every 2 weeks until the summer rains began in July, then monthly until October 1. In 1966 and 1967 survival was checked three times during the growing season. When the last survival check was made in October of each year, the total height of each tree was measured to the nearest 0.1 inch.

Near the end of the first summer the grass kill at Wing Mountain was estimated to the nearest 5 percent. At S-3 no estimates were made since little ground cover was present.

[5] *All herbicides were donated by the Geigy Chemical Company. Company names are used for the benefit of the reader and do not imply endorsement or preferential treatment by the U.S. Department of Agriculture.*

[6] *Wetting agent used was X-77, a nonionic spreader activator manufactured by Colloidal Products Corporation, Sausalito, California.*

Results

S-3 plot—
2-year-old clearcut, little ground cover

Mean seedling survival at S-3, at the end of the first year, was 88 percent (table 1).[7] Survival was higher on the herbicide-treated plots than on the unsprayed control. Although the differences between treated plots and the control averaged 15 percent, they were not statistically significant. Survival the following spring was considerably lower. One of the main causes of mortality was damage by animals (table 1).

Animals destroyed about 13 percent of the trees during the study, most of them the first winter. Primarily responsible were elk (Cervus canadensis), mule deer (Odocoileus hemionus), pocket gophers (Thomomys spp.), and rabbits and hares (Sylvilagus spp. and Lepus spp.). Another 13 percent of the trees did not visibly break dormancy in 1965 and were dead in the spring of 1966. Over 11 percent of the trees died of unknown causes and 8 percent from faulty planting, which included planting trees that were too small or of poor quality.

Total heights were not significantly different among any of the treatments throughout the study (tables 1 and 2). Because of browsing, average height in some instances was less at the end of

[7] *Results are experimental, and are not to be taken as recommendations by the U.S. Department of Agriculture.*

Figure 1.--Wing Mountain study area on Fort Valley Experimental Forest, near Flagstaff, Arizona. Area supported a dense cover of grasses, primarily Arizona fescue and mountain muhly.

Grass kill was best on that portion of the area sprayed with atrazine at a rate of 10 pounds per acre.

Table 1.--S-3 plot (little ground cover): Percent survival, total height, and percent mortality in relation to number of ponderosa pine seedlings planted in 1965, by herbicidal treatment[1]

Treatment and rate (Lb./acre)	Survival			Total height			Cause of mortality, 1965-67						
	1965	1966	1967	1965	1966	1967	Animal damage	Faulty planting	Physio-logical	Drought	Miscel-laneous	Un-known	Total
	- - Percent - -			- - Feet - -			- - - - - - - - - - Percent - - - - - - - - - -						
None(check)	75	61	46	0.38	0.33	0.39	10	15	14	1	1	12	53
Simazine:													
2.5	96	70	61	.32	.38	.49	16	3	8	0	3	9	39
5.0	92	66	42	.32	.34	.40	11	9	14	1	2	20	57
10.0	89	57	51	.33	.33	.35	9	4	21	2	2	11	49
Propazine:													
2.5	89	66	60	.33	.38	.46	13	9	13	0	4	3	42
5.0	92	65	55	.36	.40	.49	21	4	6	2	2	10	45
10.0	91	58	45	.31	.29	.37	5	7	24	1	1	17	55
Atrazine:													
2.5	87	62	54	.32	.33	.41	10	11	11	3	2	8	45
5.0	89	45	37	.35	.38	.46	20	4	19	0	6	14	63
10.0	84	62	49	.35	.32	.38	16	15	4	1	3	11	50
Mean	88	61	50	.34	.35	.42	13.1	8.1	13.4	1.1	2.6	11.5	49.8

[1]Simazine = 2-chloro-4,6-bis-(ethylamino)-s-triazine.
Propazine = 2-chloro-4,6-bis(isopropylamino)-s-triazine.
Atrazine = 2-chloro-4-ethylamino-6-isopropylamino-s-triazine.

the second growing season than at the end of the first. Approximately 44 percent of the trees were browsed during the study, and slightly over 30 percent of the trees that died had been browsed at one time or another.

Precipitation was unusually heavy in 1965. Over 5.5 inches fell in April as compared to 0.42 in April 1966. Over 23 inches of precipitation fell from April through November, which was twice as much as for the same period in 1966. Total precipitation in 1967 was similar to 1965, although the distribution differed.

Wing Mountain plot—40-year-old-clearcut, dense grass cover

First-year survival at Wing Mountain was only 50 percent (table 2). As at S-3, there were no significant differences among treatments in either survival or total height. Drought caused almost half of the mortality. First-year survival was highest on plots treated with 10 pounds of atrazine per acre (fig. 1). These plots also had the highest grass kill. Approximately 11 percent of the mortality was caused by livestock, which entered through a gap in the fence during the summer of 1966. About 15 percent of the mortality occurred during the first and second winters. A situation similar to that at S-3 existed at Wing Mountain in that over 10 percent of the trees never broke dormancy in 1965.

A rate of 10 pounds per acre of atrazine gave an average grass kill of 68 percent, which was significantly better than the other treatments. Propazine at 10 pounds was next best, with a 36 percent grass kill.

Discussion

The preemergent herbicides—simazine, atrazine, and propazine—appear to be safe for use with ponderosa pine seedlings at rates up to 10 pounds per acre.

At Wing Mountain, where heavy grass occupied the site, results were disappointing. The trees appeared to be in good condition for several weeks following planting, but then mortality became heavy. The onset of mortality coincided with the time when fescue was growing vigorously and precipitation was lacking. Despite the fact that the early spring was unusually wet, there was a period of 47 days after tree planting during which about 0.25 inch of rain fell. Grass kill was generally poor. This may be partially explained by the fact that the grass could not be sprayed until after growth had begun because of heavy snow in the spring. By the time it was possible to visit the study area for the first time in 1965, the grass was already growing. Preemergent herbicides are more efficient when the material can be incorporated into the soil during the dormant season.

Table 2.--Wing Mountain plot (dense grass cover): Percent survival, total height, and percent mortality in relation to number of ponderosa pine seedlings planted in 1965, by herbicidal treatment[1]

Treatment and rate (Lb./acre)	Survival			Total height			Cause of mortality, 1965-67						
	1965	1966	1967	1965	1966	1967	Drought	Winter kill: First winter	Winter kill: Second winter	Physiological	Animal damage	Miscellaneous	Total
	- - Percent - -			- - Feet - -			- - - - - - - - - - Percent - - - - - - - - - -						
None(check)	54	33	29	0.23	0.19	0.27	46	7	0	9	8	1	71
Simazine:													
2.5	36	15	11	.20	.24	.30	64	11	2	3	9	0	89
5.0	40	23	15	.24	.21	.32	60	2	6	6	9	2	85
10.0	53	28	24	.25	.20	.34	47	7	2	8	12	0	76
Propazine:													
2.5	47	19	10	.22	.17	.24	51	14	3	8	15	1	92
5.0	56	31	22	.25	.20	.28	44	5	11	10	6	2	78
10.0	59	31	20	.24	.16	.26	41	3	5	18	11	2	80
Atrazine:													
2.5	48	18	16	.20	.19	.26	51	17	2	10	10	1	91
5.0	57	26	23	.26	.17	.21	43	2	2	18	4	1	70
10.0	63	25	22	.24	.18	.32	37	19	0	12	8	2	78
Mean	51	25	19	.23	.19	.28	48.4	8.7	3.3	10.2	9.2	1.2	81.0

[1]Simazine = 2-chloro-4,6-bis-(ethylamino)-s-triazine.
Propazine = 2-chloro-4,6-bis(isopropylamino)-s-triazine.
Atrazine = 2-chloro-4-ethylamino-6-isopropylamino-s-triazine.

The trees planted at Wing Mountain were lifted several weeks later than normal and were in a more advanced state of growth, which may have contributed to their mortality.

Survival of pine seedlings was highest the first year on plots with the heaviest grass kill. Differences in survival were not significant, however, even though differences in grass kill were. At the end of the study, survival was higher, but not significantly so, on control plots.

Mortality during the first and second winters at Wing Mountain may have been due to winterkill. Southwestern winters are often characterized by extended periods when there is no snow cover and the ground is frozen. At S-3 a few trees died during the winter but these were included under miscellaneous causes.

A high percentage of mortality at both areas was attributed to physiological causes. An appreciable number of trees remained green throughout the summer but showed no visible signs of growth.

Many of the trees, especially at S-3, were killed by wildlife even though they were sprayed with repellents every year and the area was fenced. This was the first instance in which the author has noted extensive activity by deer and elk inside small fenced plots.

Conclusions

1. Simazine, atrazine, and propazine at rates up to 10 pounds of active ingredient per acre was applied to ponderosa pine seedlings without damage to the trees.
2. Atrazine was an effective grass killer for use in the Southwest. Previous studies have shown simazine to be effective also, but at a considerably higher cost.

USE PESTICIDES CAREFULLY!

This publication reports research involving pesticides. It does not contain recommendations for their use, nor does it imply that the uses discussed here have been registered. All uses of pesticides must be registered by appropriate State and or Federal agencies before they can be recommended.

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